Measuring Tropospheric Nitrogen

James R. Podolske

Assessing the effect of the current fleet of commercial subsonic aircraft on Earth's atmosphere requires detailed knowledge of the nitrogen chemistry of the upper troposphere and lower stratosphere. Understanding of this problem has been hampered by large uncertainties both in the abundances of the odd-nitrogen reservoir species and in the partitioning of reactive nitrogen between nitric oxide (NO) and nitrogen dioxide (NO_2). Among the nitrogen reservoir species, nitric acid (HNO_3) is expected to be one of the predominant compounds. Current instrumentation is inadequate for measuring HNO_3 and NO_2 with the speed and accuracy required to advance understanding in this area.

The open path tunable infrared monitor of the atmosphere (OPTIMA) instrument measures gas phase HNO_3 and NO_2 in the free stream of the NASA DC-8 aircraft. The instrument uses an infrared laser spectrometer coupled to an actively aligned multiple-pass Herriott sampling cavity whose open absorption path between the fuselage and the inner engine pylon achieves a free-stream absorption path length of 384 meters. To further enhance the detection sensitivity of this tunable infrared diode-laser system, high-frequency wavelength modulation spectroscopy is employed. Detection sensitivity for HNO_3 is currently in the range of 25–50 parts per trillion by volume (pptv), and NO_2 at about the 5 pptv range. In 1997, instrument design, construction, and testing were successfully completed. OPTIMA was then used in the NASA Subsonic Assessment Ozone Nitrogen Oxide Experiment mission, sampling air in and around the North Atlantic flight corridor to look for signatures of aircraft emissions that perturb the natural chemistry of the upper troposphere and lower stratosphere. Data analysis is under way.

Point of Contact: J. Podolske
(650) 604-4853
jpodolske@mail.arc.nasa.gov

Atmospheric Effects of Aircraft Emissions: SONEX

Hanwant B. Singh, James Eilers

The enormous growth in aviation has given rise to concerns that emissions from aircraft may be modifying the atmosphere in important ways. SONEX (Subsonic Assessment Ozone Nitrogen Oxide Experiment), a NASA-sponsored DC-8 aircraft mission, was conducted in October–November 1997 in the vicinity of the North Atlantic flight corridor to study the effect of aircraft emissions on the nitrogen oxide families (NO_x) and ozone (O_3). SONEX was managed by Ames Research Center. The major SONEX science objectives were (1) to obtain high-quality measurements of reactive nitrogen species (NO_x family), key ozone precursors (hydrogen oxide families (HO_x)), and tracers from the upper troposphere/lower stratosphere; and (2) to use these observations in conjunction with models to assess the effect of air-traffic emissions on NO_x and O_3. Shannon, Ireland, and Bangor, Maine, were the two primary deployment sites; they allowed access from latitudes 35° N to 70° N over the Atlantic. The Azores provided a secondary deployment site that allowed access to subtropical air masses. Survey flights, as well as maneuvers across fresh aircraft exhaust tracks in the Organized Track System between North America and Europe, were carried out. These DC-8 efforts were closely coordinated with the European DLR/POLINAT (Deutsche Forschungsanstalt für Luft- und Raumfahrt/ Pollution in North Atlantic Tracks) program, which used a higher-flying and smaller Falcon 20 aircraft as the primary research platform. Coordinated missions between the DC-8 and Falcon were performed successfully to accomplish both data-gathering and intercomparison objectives. Results from the SONEX mission are expected to allow an assessment of NO_x and HO_x upper-tropospheric photochemistry that will be greatly improved over any that have been possible to date. Anne M. Thompson of NASA Goddard Space Flight Center collaborated on this project.

Point of Contact: H. Singh
(650) 604-6769
hsingh@mail.arc.nasa.gov